

# Some Human Factors Design Principles for Effective Visualization and Collaboration of Military Operations

The image shows a screenshot of a military operations software interface. On the left, there is a 'Task Manager' window with a Gantt chart for 'Sun 25th - Sun 26th' and a list of tasks like 'Advance party', 'Rescue Package', and 'Extract to FARP'. Below it is an 'Asset List' showing units like '2 USMC RECON squads' and '2 Navy SEAL teams'. On the right is a 'Geoplot' map of a region with various icons representing assets and locations. At the bottom is a 'Resource Grid' table with columns for Source, Unit, Base Location, Current Location, Mission Type, Platform, Range, Speed, Capacity, Armament, Landing Rngs, and Status / Availability.

Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Rngs	Status / Availability
USA, USN	VLH 3	CARGRU 43	C043: Cbr	Transport-Rotor	CH-46	151	166	22 pax / 15 lft	(none)	75	Uncommitted
AUS, RAAF	Sqn 17	Darwin F1 Jones	Darwin	Attack-Fixed	F-4	1750	920	(none)	guns, bombs	5000	Training Flight
AUS, RAAF	Sqn 3	Darwin F1 Jones	Darwin	Transport-Rotor	UH-1H	250	126	8 pax / 5 kbs	(none)	75	Uncommitted
AUS, RAN	Sqn 02	Darwin RANAB	Darwin	Attack-Fixed	F-4	1750	920	(none)	guns, msls, bmb	3000	Maint 18th
AUS, RAN	Sqn 4	Darwin RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	guns, missiles	5000	Training Flight
AUS, RAN	Sqn 12	Darwin RANAB	Darwin	Transport-Rotor	H-45	150	18 pax / 8.4 kbs	(none)	(none)	75	Maint 18th
USA, USAF	LAW 4	Darwin F1 Jones	Darwin	Attack-Fixed	F/A-18C	154	400	50 p / 130 l	l, m, r	2020	Maint 21st
USA, USN	ARW 12	Darwin F1 Jones	Darwin	Transport	VC-140	2450	2450	30 kbs	(none)	2020	E Timer NFO
USA, USN	VLH 1	Darwin F1 Jones	Darwin	Transport-Rotor	UH-1N	250	126	8 pax / 5 kbs	(none)	75	Maint 18th
USA, USAF	HAW 47	CA: Travis AFB	Gum	Transport-Fixed	C-141	2800	500	153 pax / 90 kbs	(none)	4000	In transit



<b>Report Documentation Page</b>			<i>Form Approved OMB No. 0704-0188</i>	
<p>Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p>				
1. REPORT DATE <b>JAN 2002</b>	2. REPORT TYPE	3. DATES COVERED <b>00-00-2002 to 00-00-2002</b>		
4. TITLE AND SUBTITLE <b>Some Human Factors Design principles for Effective Visualization and Collaboration of Military Operations</b>			5a. CONTRACT NUMBER	
			5b. GRANT NUMBER	
			5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)			5d. PROJECT NUMBER	
			5e. TASK NUMBER	
			5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Office of Naval Research, Cognitive and Neural Sciences, Code 342, Arlington, VA, 22203</b>			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)	
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>				
13. SUPPLEMENTARY NOTES <b>ONR TC3 Workshop, Cognitive Elements of Effective Collaboration, 15-17 Jan 2002, San Diego, CA.</b>				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>35</b>
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>		

# Authors

Mark St. John, PSE



Harvey S. Smallman, PSE



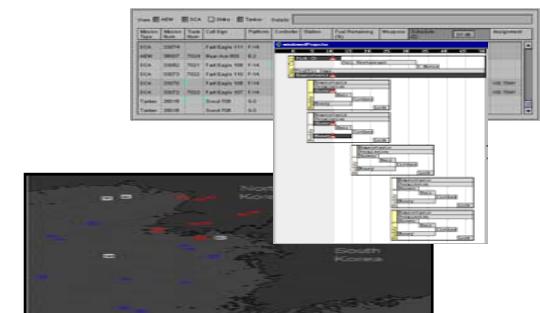
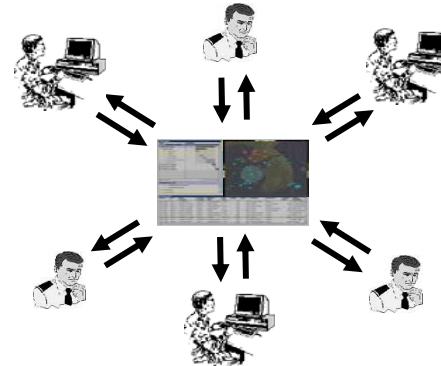
Heather M. Oonk, PSE



Glenn A. Osga, SSC

# Collaboration in Military Command and Control

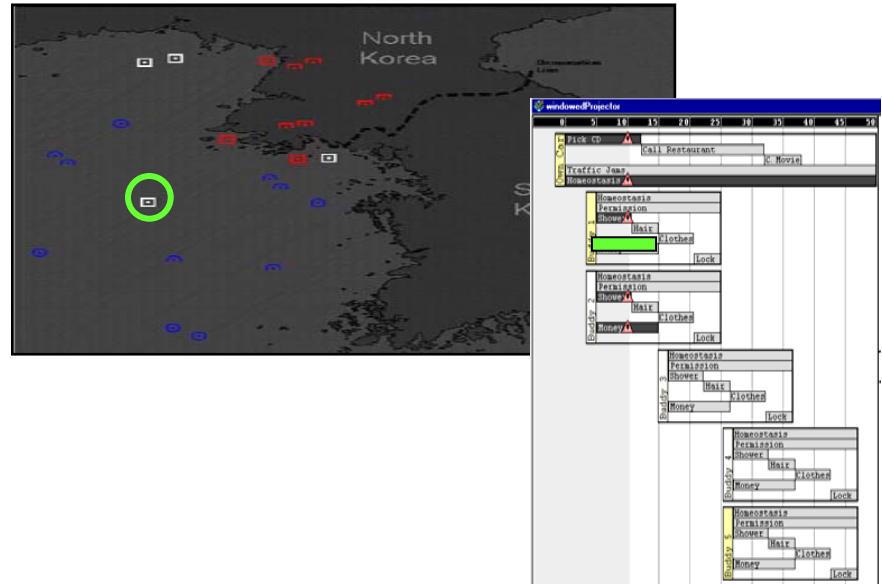
- ◆ Interactions are hierarchical and distributed
  - Need information sharing and plan coordination
- ◆ Interactions are asynchronous
  - Need intervening representations
- ◆ Plans are complex and many dimensional
  - Goals, tasks, assets, priorities, schedules...
  - Need information visualization and integration



# Architecture Principle: Slice & Link

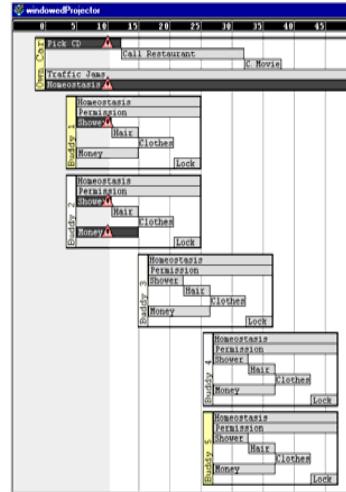
- ◆ Use multiple “2D” displays
  - Geoplot
    - Assets by location
  - Task Manager
    - Tasks by time
  - Resource Grid
    - Assets by attribute
  - Etc.
- ◆ Use Dynamic Visual Linking
  - “Content addressable memory”

Mission Type	Mission Num	Track	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (C)	01:46	Assignment
DCA	33074		Fast Eagle 111	F-14	BW	(assigned)	100	2 2 0	2330 - 0200		
AEW	36007	7024	Bear Ace 600	E-2	BW	Albany	80	0 0 0	0030 - 0200		
DCA	33052	7021	Fast Eagle 108	F-14	BW-D	San Diego	75	2 1 0	0030 - 0200		
DCA	33073	7022	Fast Eagle 110	F-14	BW-D	San Diego	75	2 1 0	0030 - 0200		
DCA	33072	7023	Fast Eagle 107	F-14	BW-T	Newport	50	1 1 1	0030 - 0200		VID 7041
Tanker	35015		Scout 705	S-3	BR	Houston	100	0 0 0	0030 - 0200		
Tanker	35016		Scout 706	S-3	BR	(assigned)	100	0 0 0	0030 - 0200		



# “2D” Display Design

- ◆ Task Manager
  - Task by time
  - Schedules
  - Dependencies
  - Implications of delays
  - Etc.

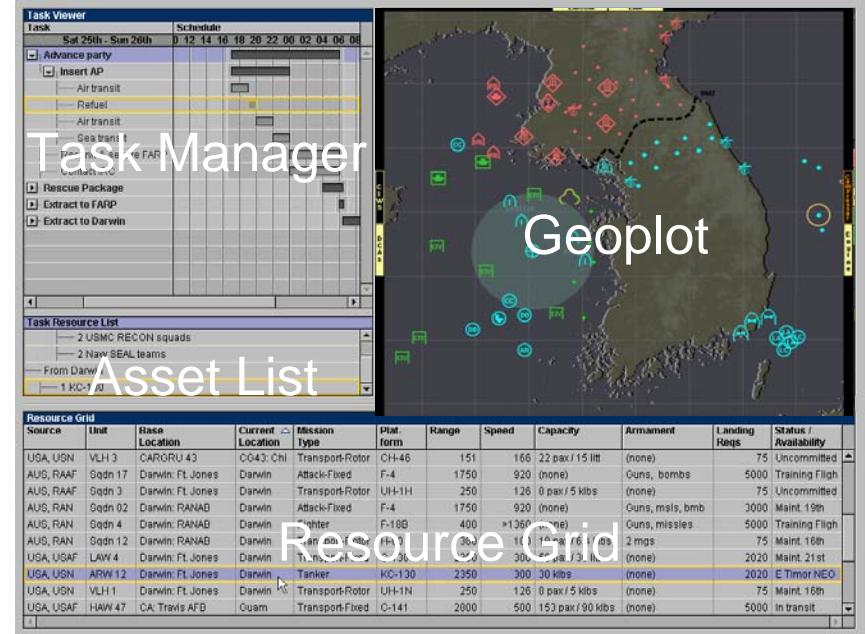


- ◆ Resource Grid
  - Assets by attributes
  - Sort, filter, retrieve, compare assets and their attributes

# PSYCLOPS

## A Single Integrated “Eye” on the Situation

- ◆ Integrated Tools to Augment Command and Control
  - More effective situation and plan visualization tools with
  - Visually interlinked databases for content addressable memory and context tracking
- ◆ Linked components
  - Task Manager
    - Task components and schedule
  - Resource Grid
    - Asset data and availability
  - Asset List
    - Correlation of assets to tasks
  - Geoplot
    - Locations of assets

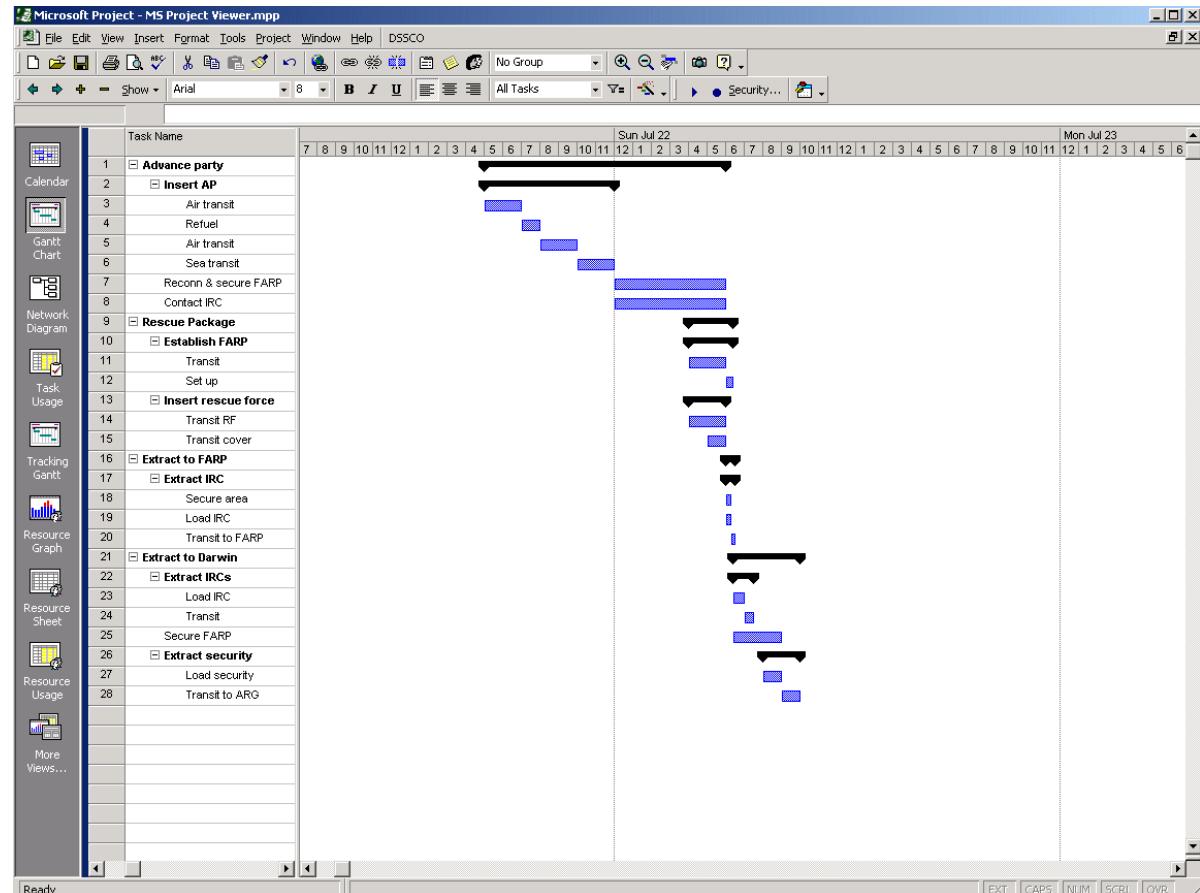


# Example Scenario: NEO in East Timor

- ◆ Noncombatant Evacuation Operation
  - CH-53s, CH-46s, KC-130s, AC-130s, MC-130s, AV-8Bs, AH-1s, USMC RECON teams, Navy SEAL teams, Medical corps teams
- ◆ Evacuate approx. 50 Red Cross workers from rebel-held territory in East Timor
- ◆ Work with local embassy to develop an evacuation plan
- ◆ Insert advance forces to recon and secure staging areas
- ◆ Insert main body rescue force
- ◆ Extract Red Cross workers and the rescue force

# NEO with Current Tools

- ◆ Are there Darwin-based tasks or resources?
- ◆ What would it mean if there were?
- ◆ Do I need to reassign anything?
- ◆ How will I find replacement resources?
- ◆ Which tasks need rescheduling?



# NEO with PSYCLOPS

- ◆ Are there Darwin-based tasks or resources?
- ◆ What would it mean if there were?
- ◆ Do I need to reassign anything?
- ◆ How will I find replacement resources?
- ◆ Which tasks need rescheduling?

**Task Viewer**

Task	Schedule
Sat 25th - Sun 26th	0 12 14 16 18 20 22 00 02 04 06 08
<input checked="" type="checkbox"/> Advance party	<ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Insert AP</li> <li><input type="checkbox"/> Refuel</li> <li><input type="checkbox"/> Air transit</li> <li><input type="checkbox"/> Sea transit</li> <li><input type="checkbox"/> Recon &amp; secure FARP</li> <li><input type="checkbox"/> Contact IRC</li> </ul>
<input type="checkbox"/> Rescue Package	
<input type="checkbox"/> Extract to FARP	
<input type="checkbox"/> Extract to Darwin	

**Task Resource List**

- 2 USMC RECON squads
- 2 Navy SEAL teams
- From Darwin
- 1 KC-130

**Resource Grid**

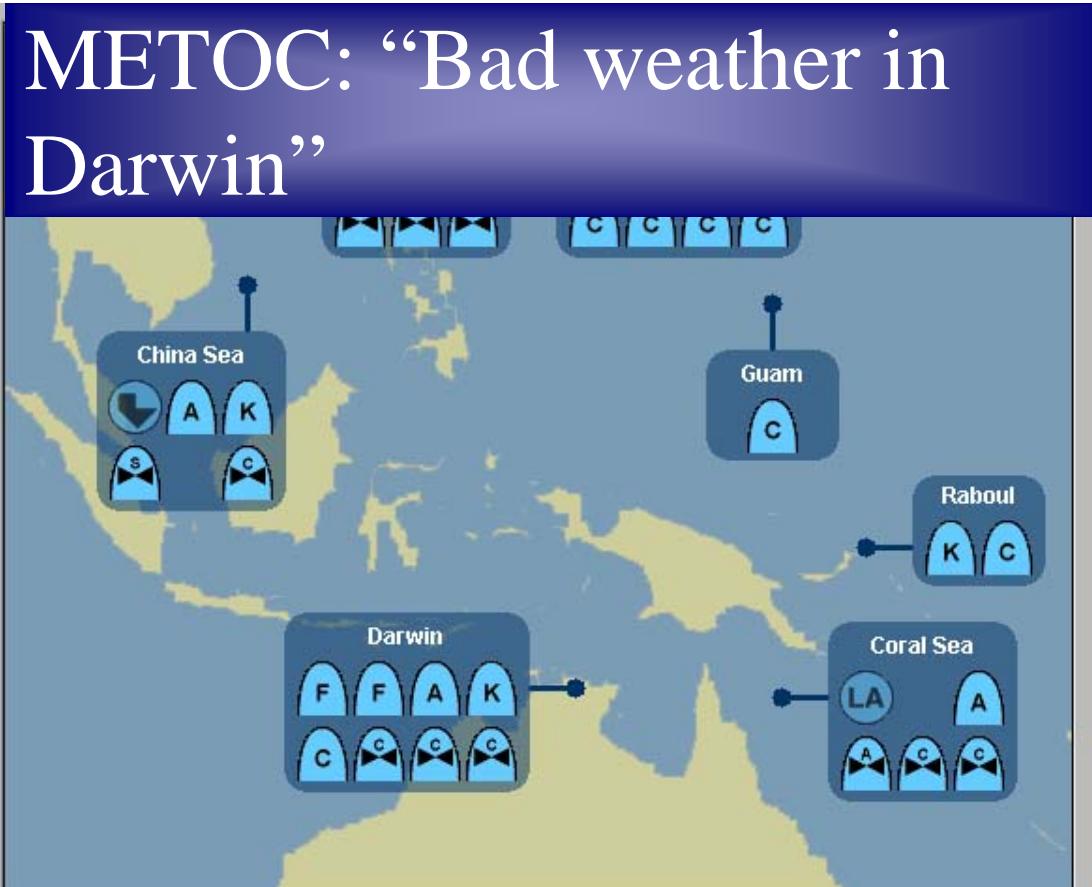
Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USN	VLH 3	CARGRU 43	CG43: Chi	Transport-Rotor	CH-46	151	166	22 pax / 15 litt	(none)	75	Uncommitted
AUS, RAAF	Sqn 17	Darwin: Ft. Jones	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, bombs	5000	Training Fligh
AUS, RAAF	Sqn 3	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1H	250	126	8 pax / 5 klbs	(none)	75	Uncommitted
AUS, RAN	Sqn 02	Darwin: RANAB	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, msrls, bmb	3000	Maint. 19th
AUS, RAN	Sqn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missiles	5000	Training Fligh
AUS, RAN	Sqn 12	Darwin: RANAB	Darwin	Transport-Rotor	H-60	380	180	18 pax / 6.4 klbs	2 mrgs	75	Maint. 16th
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	VLH 1	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1N	250	126	8 pax / 5 klbs	(none)	75	Maint. 16th
USA, USAF	HAW 47	CA: Travis AFB	Guam	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	In transit

**Task Viewer**

Task	Schedule
Sat 25th - Sun 26th	02 04 06 08 10 12 14 16 18 20 22
Advance party	
Rescue Package	
Extract to FARP	
Extract to Darwin	

**Task Resource List**

Resource Type	Count
Transport Fixed	10
Attack Fixed	5
Attack Rotor	2
Support	2



**Resource Grid**

Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USAF	HAW 47	CA: Travis AFB	Guam	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	In transit
USA, USAF	HAW 23	Okinawa	Okinawa	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	Team Spirit
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st
USA, USAF	MAW 8	Kadena AB: Japan	Kadena	Transport-Fixed	C-17	2760	390	102 pax / 90 klbs	(none)	4700	Team Spirit
USA, USAF	MAW 3	Yokota AB: Japan	Yokota	Transport-Fixed	C-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USMC	AW 3	Okinawa	Okinawa	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USN	VAS 22	CARGRU 43	CG43: Chi	ASW-Rotor	SH-60	150	155	3 torp	3 torpedos	75	Uncommitted
USA, USN	TF 33	ARG: Belleau Wood	ARG: Coral	Attack-Fixed	AV-8B	800	630	(none)	Guns, msls, bmb	100	E Timor NEO
USA, USN	TF 57	ARG: Tarawa	ARG: Sea	Attack-Fixed	AV-8B	800	630	(none)	Guns, msls, bmb	75	Team Spirit
USA, USN	TF 33	ARG: Belleau Wood	ARG: Coral	Attack-Rotor	AH-1	317	173	(none)	Guns, msls, bmb	75	E Timor NEO

**Task Viewer**

Task	Schedule
Sat 25th - Sun 26th	02 04 06 08 10 12 14 16 18 20 22
Advance party	
Rescue Package	
Extract to FARP	
Extract to Darwin	

**Task Resource List**



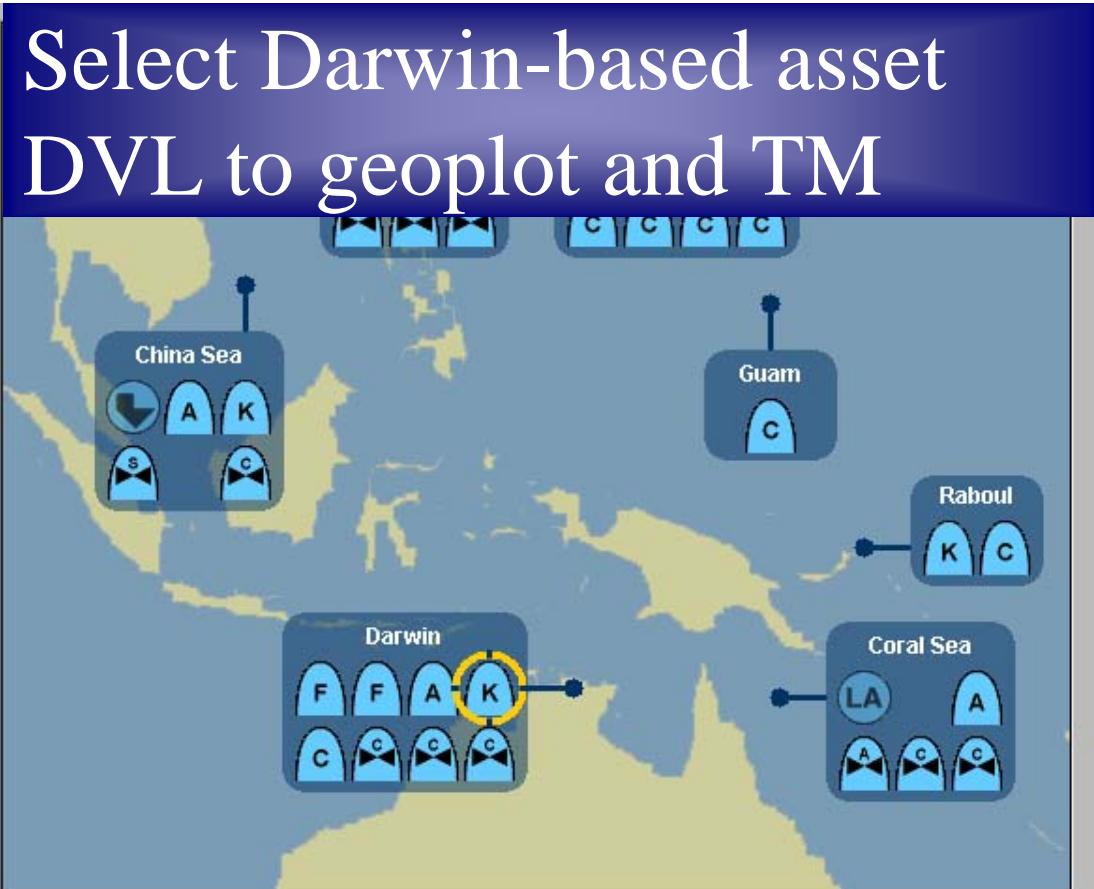
Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USN	VLH 3	CARGRU 43	CG43: Chi	Transport-Rotor	CH-46	151	166	22 pax / 15 litt	(none)	75	Uncommitted
AUS, RAAF	Sqdn 17	Darwin: Ft. Jones	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, bombs	5000	Training Fligh
AUS, RAAF	Sqdn 3	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1H	250	126	8 pax / 5 klbs	(none)	75	Uncommitted
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	VLH 1	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1N	250	126	8 pax / 5 klbs	(none)	75	Maint. 16th
AUS, RAN	Sqdn 02	Darwin: RANAB	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, msls, brnb	3000	Maint. 19th
AUS, RAN	Sqdn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missles	5000	Training Fligh
AUS, RAN	Sqdn 12	Darwin: RANAB	Darwin	Transport-Rotor	H-60	380	180	18 pax / 6.4 klbs	2 mgs	75	Maint. 16th
USA, USN	MAW 2	GUAM:NAB	Rabaul	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Training Fligh

**Task Viewer**

Task	Schedule
Sat 25th - Sun 26th	02 04 06 08 10 12 14 16 18 20 22
Advance party	
Rescue Package	
Extract to FARP	
Extract to Darwin	

**Task Resource List**

Resource Type	Count
Aircraft	10
Boats	5
Personnel	15



**Resource Grid**

Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USN	VLH 3	CARGRU 43	CG43: Chi	Transport-Rotor	CH-46	151	166	22 pax / 15 litt	(none)	75	Uncommitted
AUS, RAAF	Sqdn 17	Darwin: Ft. Jones	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, bombs	5000	Training Fligh
AUS, RAAF	Sqdn 3	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1H	250	126	8 pax / 5 klbs	(none)	75	Uncommitted
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	VLH 1	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1N	250	126	8 pax / 5 klbs	(none)	75	Maint. 16th
AUS, RAN	Sqdn 02	Darwin: RANAB	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, msls, brnb	3000	Maint. 19th
AUS, RAN	Sqdn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missles	5000	Training Fligh
AUS, RAN	Sqdn 12	Darwin: RANAB	Darwin	Transport-Rotor	H-60	380	180	18 pax / 6.4 klbs	2 mgs	75	Maint. 16th
USA, USN	MAW 2	GUAM:NAB	Rabaul	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Training Fligh

**Task Viewer**

Task	Schedule
Sat 25th - Sun 26th	0 12 14 16 18 20 22 00 02 04 06 08
<input checked="" type="checkbox"/> Advance party	<input checked="" type="checkbox"/> Insert AP
--- Air transit	
--- Refuel	
--- Air transit	
--- Sea transit	
--- Recon & secure FARP	
--- Contact IRC	
<input checked="" type="checkbox"/> Rescue Package	
<input checked="" type="checkbox"/> Extract to FARP	
<input checked="" type="checkbox"/> Extract to Darwin	

**Task Resource List**

- 2 USMC RECON squads
- 2 Navy SEAL teams
- From Darwin
- 1 KC-130

Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USN	VLH 3	CARGRU 43	CG43: Chi	Transport-Rotor	CH-46	151	166	22 pax / 15 litt	(none)	75	Uncommitted
AUS, RAAF	Sqn 17	Darwin: Ft. Jones	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, bombs	5000	Training Fligh
AUS, RAAF	Sqn 3	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1H	250	126	8 pax / 5 klbs	(none)	75	Uncommitted
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	VLH 1	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1N	250	126	8 pax / 5 klbs	(none)	75	Maint. 16th
AUS, RAN	Sqn 02	Darwin: RANAB	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, msls, brnb	3000	Maint. 19th
AUS, RAN	Sqn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missles	5000	Training Fligh
AUS, RAN	Sqn 12	Darwin: RANAB	Darwin	Transport-Rotor	H-60	380	180	18 pax / 6.4 klbs	2 mgs	75	Maint. 16th
USA, USN	MAW 2	GUAM:NAB	Rabaul	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Training Fligh

Expand “Advance Party” task  
Refueling task is soon!



# Sort by Mission Type to look for alternative tankers

**Task Viewer**

Task	Schedule
Sat 25th - Sun 26th	0 12 14 16 18 20 22 00 02 04 06 08
<input checked="" type="checkbox"/> Advance party	
<input checked="" type="checkbox"/> Insert AP	
Air transit	
Refuel	
Air transit	
Sea transit	
Reconn & secure FARP	
Contact IRC	
<input checked="" type="checkbox"/> Rescue Package	
<input checked="" type="checkbox"/> Extract to FARP	
<input checked="" type="checkbox"/> Extract to Darwin	

**Task Resource List**

- 2 USMC RECON squads
- 2 Navy SEAL teams
- From Darwin
- 1 KC-130



**Resource Grid**

Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USAF	HAW 23	Okinawa	Okinawa	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	Team Spirit
USA, USMC	AW 3	Okinawa	Okinawa	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USAF	MAW 3	Yokota AB: Japan	Yokota	Transport-Fixed	C-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USN	ARW 12	CARGRU 43	CG43: Chi	Tanker	KC-130	2800	300	30 klbs	(none)	2020	Team Spirit
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	ARW 12	Rabaul: Ft. Smith	Rabaul	Tanker	KC-130	2350	300	30 klbs	(none)	2020	Training Fligh
USA, USN	ARW 12	Yokota AB: Japan	Yokota	Tanker	KC-130	2800	300	30 klbs	(none)	2020	Uncommitted
USA, USN	VF 34	CARGRU 43	CG43: Chi	Fighter	F/A-18	575	>1360	(none)	Guns, msils, bmb	5000	Uncommitted
AUS, RAN	Sqn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missles	5000	Training Fligh
USA, USAF	FW 34	Kadena AB: Japan	Kadena	Fighter	F-15D	3450	1875	(none)	20 mm, 8 missles	5000	Team Spirit

# Rabaul-based tanker is available

**Task Viewer**

Task	Schedule
Sat 25th - Sun 26th	0 12 14 16 18 20 22 00 02 04 06 08
<input checked="" type="checkbox"/> Advance party	
<input checked="" type="checkbox"/> Insert AP	
- Air transit	
- Refuel	
- Air transit	
- Sea transit	
- Recon & secure FARP	
- Contact IRC	
<input checked="" type="checkbox"/> Rescue Package	
<input checked="" type="checkbox"/> Extract to FARP	
<input checked="" type="checkbox"/> Extract to Darwin	

**Task Resource List**

- 2 USMC RECON squads
- 2 Navy SEAL teams
- From Darwin
- 1 KC-130

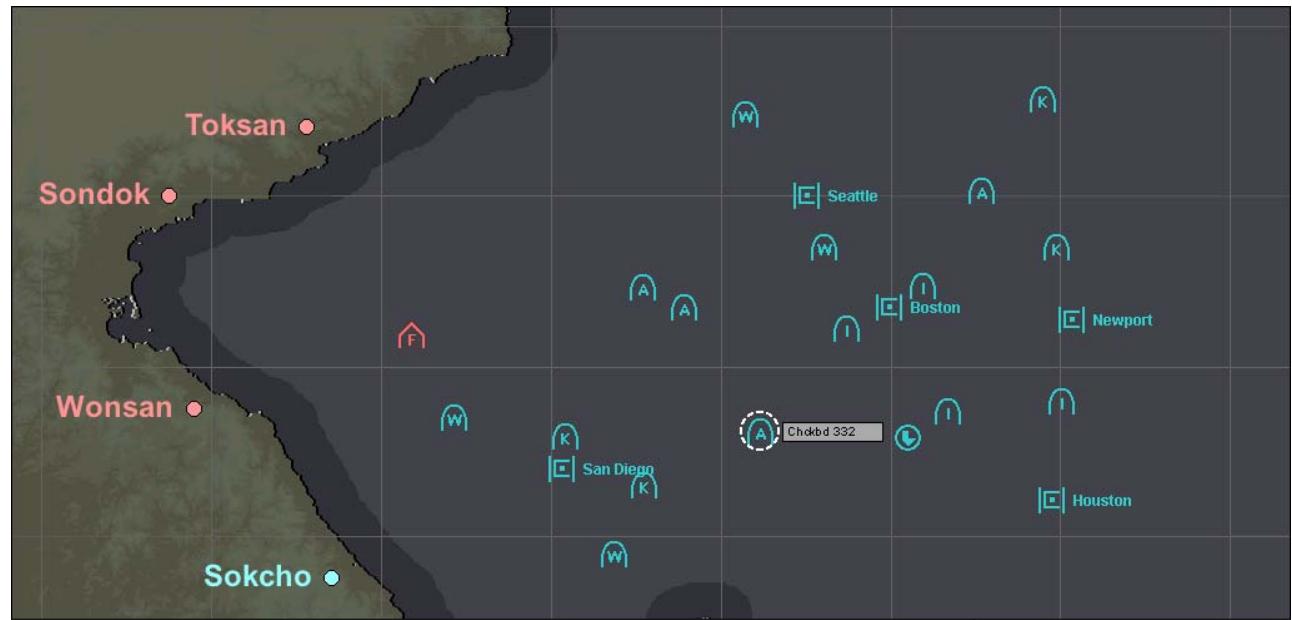


Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USAF	HAW 23	Okinawa	Okinawa	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	Team Spirit
USA, USMC	AW 3	Okinawa	Okinawa	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USAF	MAW 3	Yokota AB: Japan	Yokota	Transport-Fixed	C-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USN	ARW 12	CARGRU 43	CG43: Chi	Tanker	KC-130	2800	300	30 klbs	(none)	2020	Team Spirit
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	ARW 12	Rabaul: Ft. Smith	Rabaul	Tanker	KC-130	2350	300	30 klbs	(none)	2020	Training Fligh
USA, USN	ARW 12	Yokota AB: Japan	Yokota	Tanker	KC-130	2800	300	30 klbs	(none)	2020	Uncommitted
USA, USN	VF 34	CARGRU 43	CG43: Chi	Fighter	F/A-18	575	>1360	(none)	Guns, msils, bmb	5000	Uncommitted
AUS, RAN	Sqdn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missles	5000	Training Fligh
USA, USAF	FW 34	Kadena AB: Japan	Kadena	Fighter	F-15D	3450	1875	(none)	20 mm, 8 missles	5000	Team Spirit

# Plans, Assets, & Attributes

- ◆ It is difficult to keep track of assets and their status
  - Distilled and organized from multiple sources
- ◆ It is difficult to compare the attributes of assets
- ◆ It can even be difficult to find assets

Where is the interceptor with the least fuel?



# Basic GeoPlot

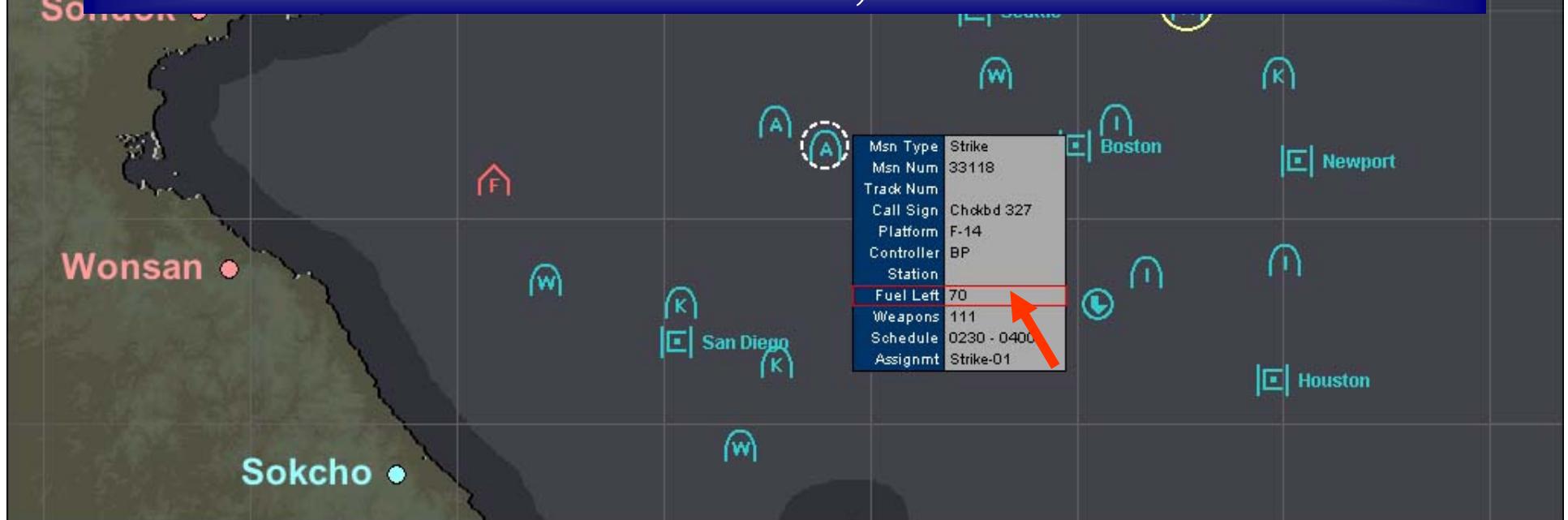
Search for strike aircraft, examine fuel level



Where is the Strike aircraft with the lowest fuel level?

# Basic GeoPlot

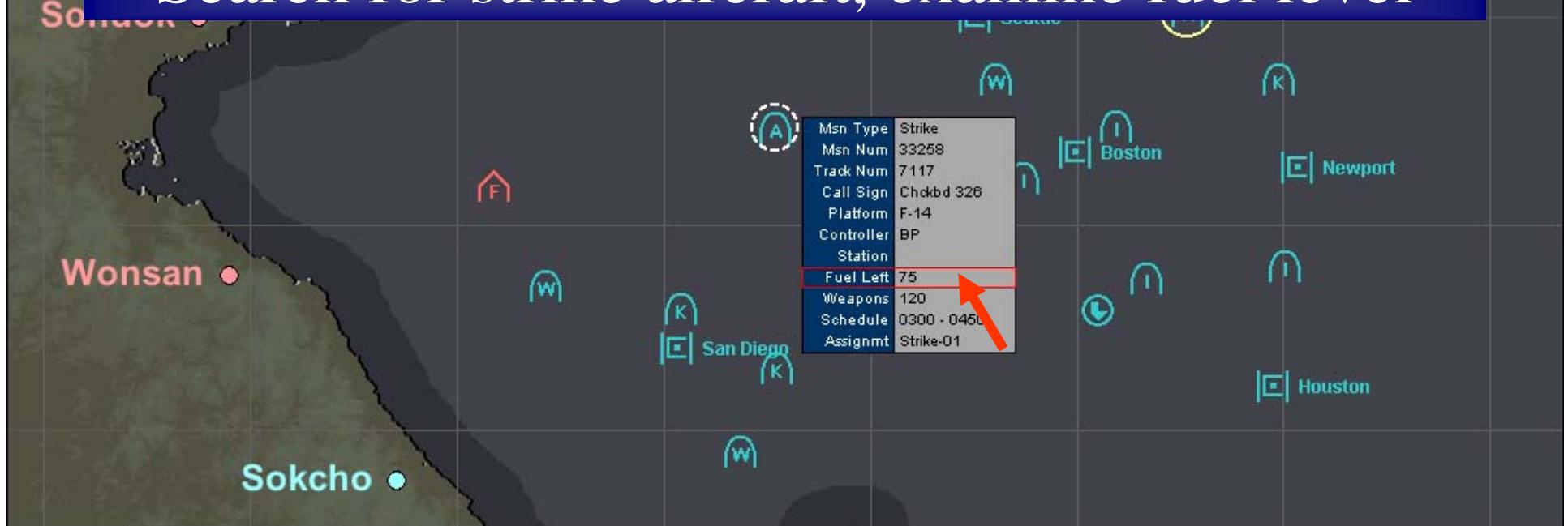
Search for strike aircraft, examine fuel level



Where is the Strike  
aircraft with the  
lowest fuel level?

# Basic GeoPlot

Search for strike aircraft, examine fuel level



Where is the Strike aircraft with the lowest fuel level?

# Basic GeoPlot

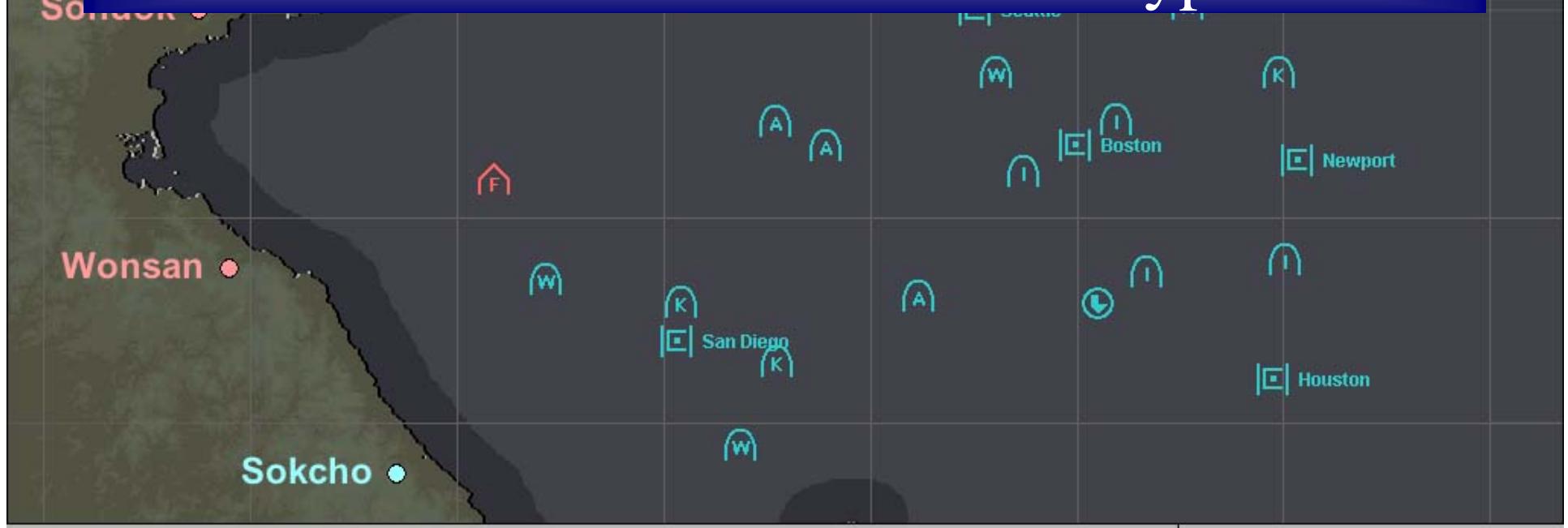
Return to strike aircraft with lowest fuel



Where is the Strike  
aircraft with the  
lowest fuel level?

# RG: Method 1

## Select a filter for all mission types



View:  AEW  DCA  Strike  Tanker

Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule	03:00	Assignment
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300		
AEW	36105		Bear Ace 603	E-2	BW	San Diego	80	000	0300 - 0450		
AEW	36138	7187	Bear Ace 610	E-2	BW	Seattle	75	000	0120 - 0220		
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300		
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400		
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300		
DCA	33138		Fast Eagle 102	F-14	BW-T	Boston	90	020	0230 - 0330		
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450		

Where is the Strike aircraft with the lowest fuel level?

# RG: Method 1

## Sort by Fuel Remaining



View:  AEW  DCA  Strike  Tanker

Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule	03:00	Assignment
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450		
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300		
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300		
Tanker	35066		Scout 706	S-3	BR	Seattle	30	000	0230 - 0400		
Tanker	35093		Scout 701	S-3	BR	Boston	30	000	0300 - 0450		
Strike	34132	7103	Chckbd 332	FA-18	BP		35	001	0030 - 0130		Strike-01
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400		
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300		

Where is the Strike aircraft with the lowest fuel level?

# RG: Method 1

Roll down looking for a strike aircraft



View:  AEW  DCA  Strike  Tanker

DCA	33202	Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450		
Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule	Assignment
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450	
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300	
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300	
Tanker	35066		Scout 706	S-3	BR	Seattle	30	000	0230 - 0400	
Tanker	35093		Scout 701	S-3	BR	Boston	30	000	0300 - 0450	
Strike	34132	7103	Chckbd 332	FA-18	BP		35	001	0030 - 0130	Strike-01
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400	
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300	

Where is the Strike aircraft with the lowest fuel level?

# RG: Method 1

Roll down looking for a strike aircraft



View:  AEW  DCA  Strike  Tanker

Strike	34132	7103	Chokbd 332	FA-18	BP		35	001	0030 - 0130		Strike-01
Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	03:00	Assignment
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450		
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300		
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300		
Tanker	35066		Scout 706	S-3	BR	Seattle	30	000	0230 - 0400		
Tanker	35093		Scout 701	S-3	BR	Boston	30	000	0300 - 0450		
Strike	34132	7103	Chokbd 332	FA-18	BP		35	001	0030 - 0130		Strike-01
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400		
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300		

Where is the Strike aircraft with the lowest fuel level?

# RG: Method 1

## Select row



View:  AEW  DCA  Strike  Tanker

Strike	34132	7103	Chokbd 332	FA-18	BP	35	001	0030 - 0130	Strike-01	
Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	Assignment
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450	
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300	
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300	
Tanker	35066		Scout 706	S-3	BR	Seattle	30	000	0230 - 0400	
Tanker	35093		Scout 701	S-3	BR	Boston	30	000	0300 - 0450	
Strike	34132	7103	Chokbd 332	FA-18	BP	35	001	0030 - 0130	Strike-01	
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400	
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300	

Where is the Strike aircraft with the lowest fuel level?

## RG: Method 2

Select a filter for only strike aircraft



Where is the Strike aircraft with the lowest fuel level?

Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule	03:00	Assignment
Strike	33258	7117	Chokbd 326	F-14	BP		75	120	0300 - 0450		Strike-01
Strike	33118		Chokbd 327	F-14	BP		70	111	0230 - 0400		Strike-01
Strike	34067	7154	Chokbd 331	FA-18	BP		65	122	0130 - 0330		Strike-01
Strike	34432	7103	Chokbd 332	FA-18	BP		35	001	0030 - 0130		Strike-01

## RG: Method 2

Roll down looking for lowest fuel



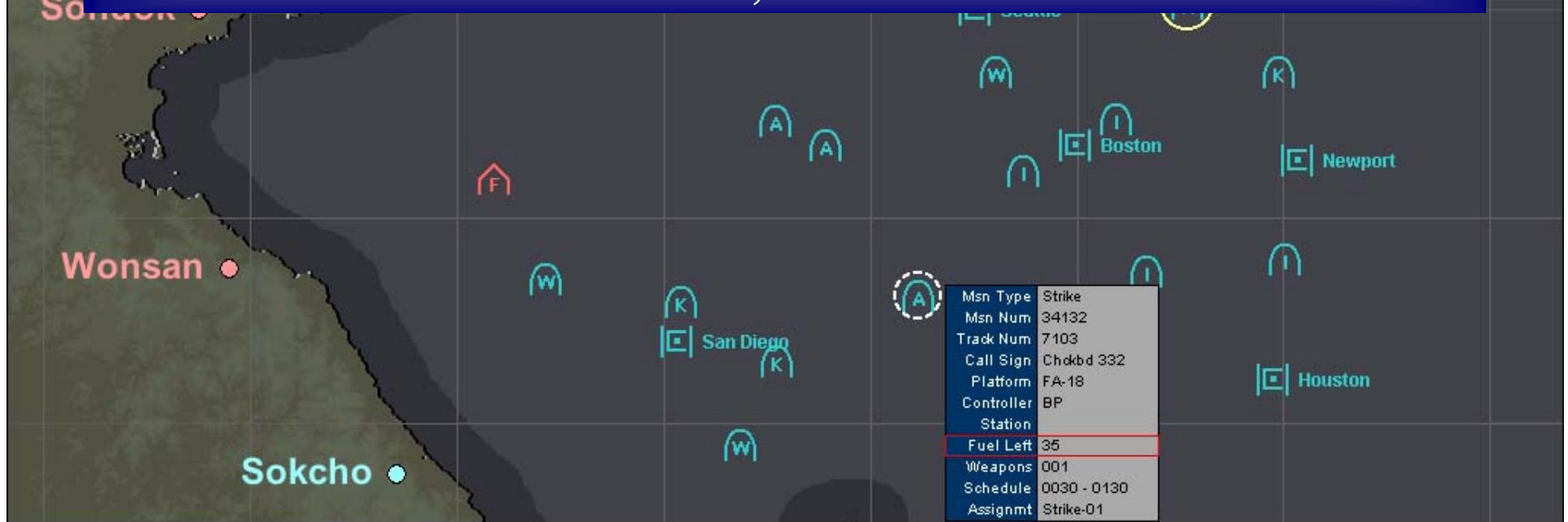
View:  AEW  DCA  Strike  Tanker

Strike	34132	7103	Chokbd 332	FA-18	BP	35	001	0030 - 0130	Strike-01	
Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	Assignment
Strike	33258	7117	Chokbd 326	F-14	BP	75	120	0300 - 0450		Strike-01
Strike	33118		Chokbd 327	F-14	BP	70	111	0230 - 0400		Strike-01
Strike	34067	7154	Chokbd 331	FA-18	BP	65	122	0130 - 0330		Strike-01
Strike	34132	7103	Chokbd 332	FA-18	BP	35	001	0030 - 0130		Strike-01

Where is the Strike aircraft with the lowest fuel level?

# Enhanced GeoPlot

Find/Next search, examine fuel level



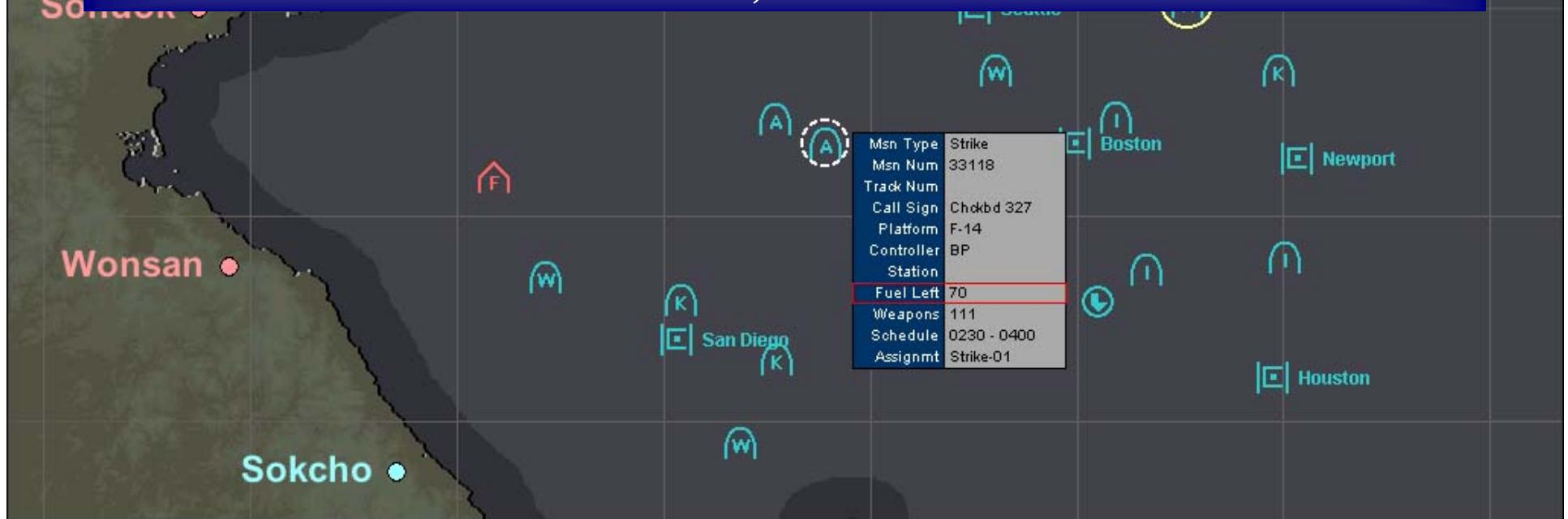
**AEW** **DCA** **Strike** **Tanker**



Where is the Strike aircraft with the lowest fuel level?

# Enhanced GeoPlot

Find/Next search, examine fuel level

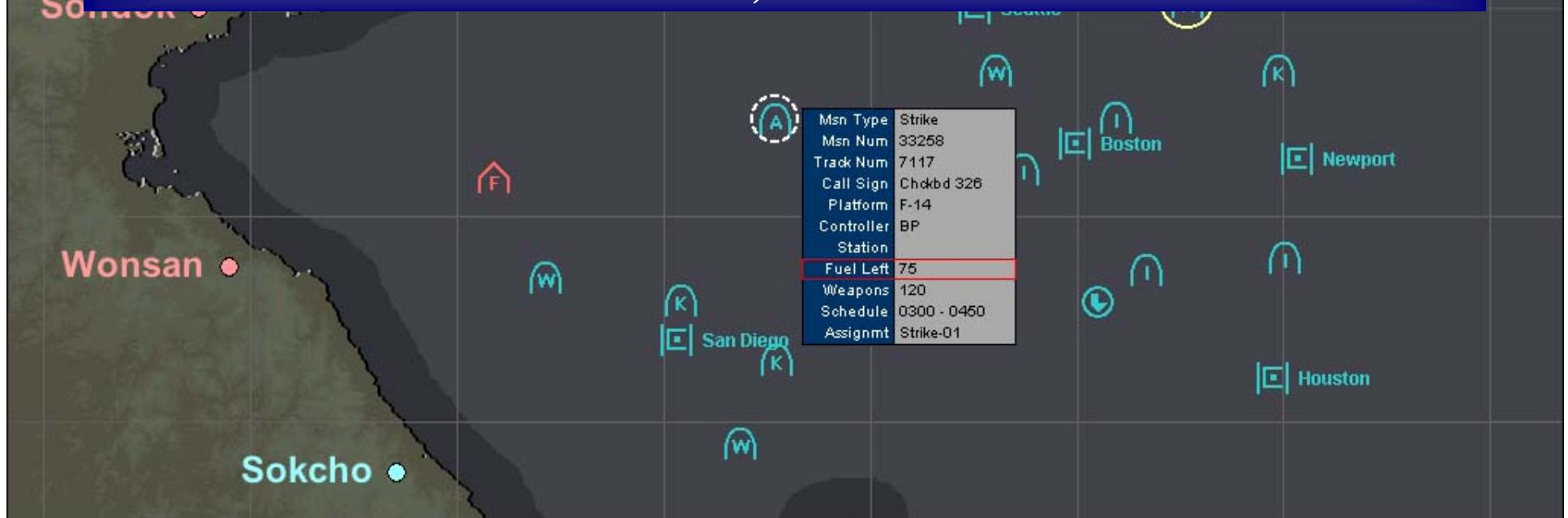


**AEW**   **DCA**   **Strike**   **Tanker**

Where is the Strike  
aircraft with the  
lowest fuel level?

# Enhanced GeoPlot

Find/Next search, examine fuel level



**AEW**   **DCA**   **Strike**   **Tanker**

Where is the Strike  
aircraft with the  
lowest fuel level?

# Enhanced GeoPlot

Return to strike aircraft with lowest fuel



**AEW** **DCA** **Strike** **Tanker**

Where is the Strike  
aircraft with the  
lowest fuel level?

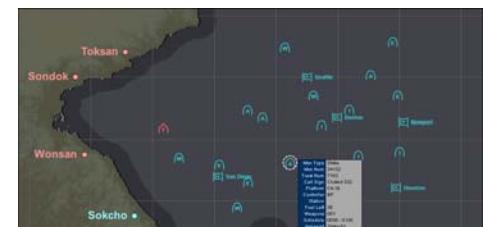
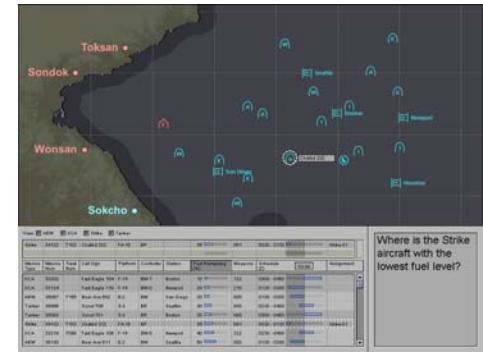
# Design Alternatives for Showing Attributes

- ◆ Resource Grid
  - Tabular and spatial organizations
  - Dynamic visual linking
  - But two displays
- ◆ Basic Geoplot plus pop-up list
  - Spatial organization only
  - Single, integrated display
  - But search is difficult
- ◆ Enhanced Geoplot
  - Spatial organization only
  - Single, integrated display
  - Find/Next search
  - Still one-at-a-time display



# Example Questions from the Experiment

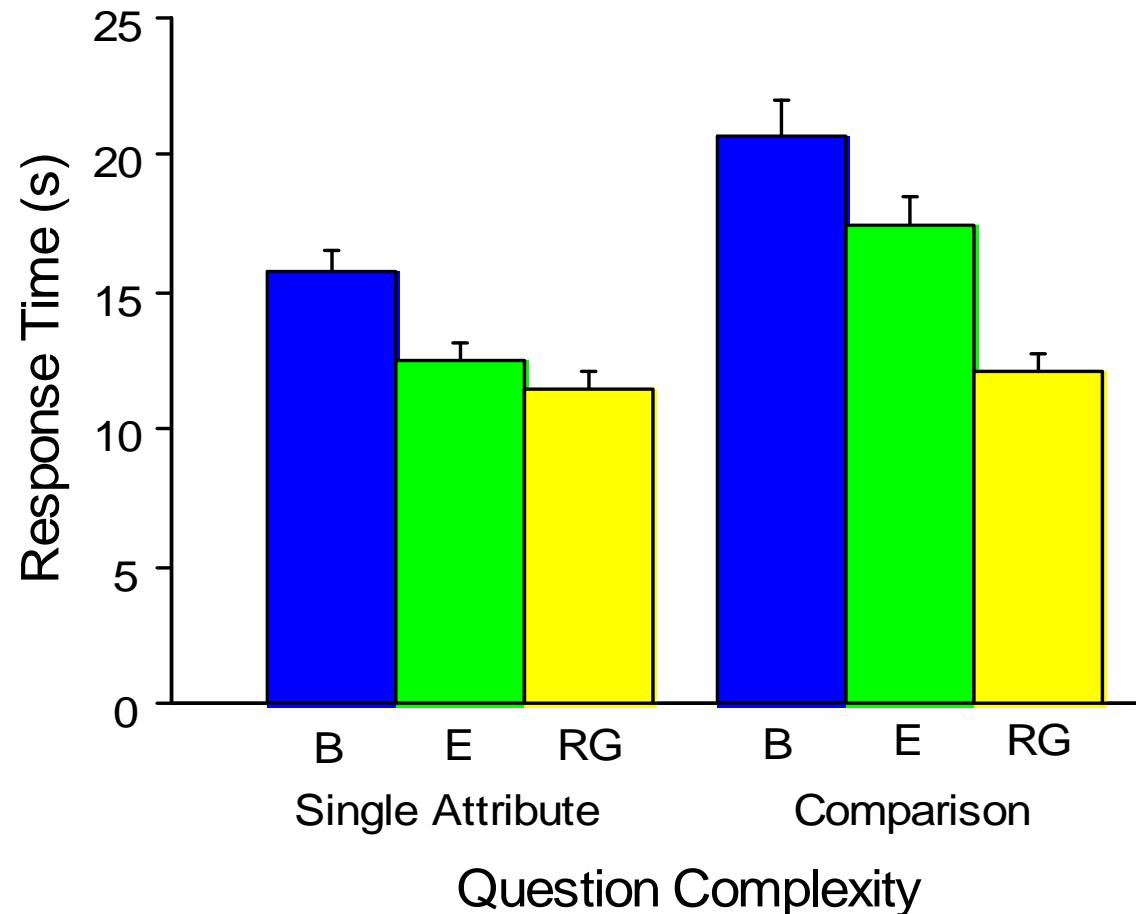
- ◆ Data-based search vs. map-based search
  - Where is the aircraft that is closest to the carrier?
  - What is the platform of the aircraft with track number 7022?
- ◆ Single attribute vs. comparison
  - Where is the Strike aircraft with call sign Checkerboard 327?
  - What is the call sign of the aircraft with the lowest fuel level?
- ◆ Single mission vs. all aircraft
  - Where is the (DCA) aircraft with the fewest weapons?



# Comparisons Among Assets

*Where is the strike aircraft with the lowest fuel level?*

- ◆ Comparisons were slower than Singles
  - E.g. Searching the geoplot and remembering previous values
- ◆ Except for RG
  - Sorting and comparing down a column
- ◆ For comparisons, RG was 42% faster than Basic



## Conclusions

- ◆ Active tables for asset/attribute comparisons
  - Filter-able, sort-able, scan-able tabular display
- ◆ Architecture principle: “Slice and Link”
  - Multiple 2D displays, plus
  - Dynamic Visual Linking
- ◆ Military command and control is a rich domain for investigation of collaboration principles and innovative visualization concepts
- ◆ Many of these principles and concepts apply to multiple domains

